Modern science and engineering workplaces now use computational practices to aid in analyzing and designing products, processes, and systems. In light of the integration of these practices in the workplace, engineering educators continue to identify the breadth and depth of computation, data science, and modeling and simulation skills needed by the 21st Century STEM workforce. This agenda establishes an integrated, evidence-based program of research and education centered on how people develop model-based reasoning through authentic computational practices in science and engineering. Through a series of qualitative and quantitative research studies, we attempt to understand (i) How can faculty support student model-based reasoning using computational tools? and (ii) How can students develop computational adaptive expertise?

This presentation (1) provides an overview of ways in which engineering instructors have integrated computation practices as part of their undergraduate curriculum; (2) identifies the different forms of reasoning and knowledge used when students engage in these practices as they perform problem-solving; and (3) describes opportunities and challenges students have encountered when engaging in these practices. The ultimate goal is to identify pedagogies and learning strategies that can result in students’ computational adaptive expertise. Lessons learned from these studies have resulted in a computational cognitive apprenticeship model that can be used as a guideline to support learners in using computation meaningfully for their learning and overcoming challenges when engaged in this complex practice.
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